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(54) GUIDING A STRAND-FORM MATERIAL UNDER A SOURCE OF IRRADIATION

(71) We, SIEMENS AKTIENGESELLSCHAFT, a German Company of Berlin and Munich, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the guiding of a strand-form material under a source of irradiation.

Conventionally, polyethylene sheated cables (VPE cables) are manufactured by drawing the sheathed cable through a vapour filled tube, the vapour being for example under a pressure of 16 atmospheres excess pressure. Due to thermal action, a a cross-linking agent decomposes into radicals which produce spatially branched compounds into the polyethylene. Due to this cross-linking, the polyethylene behaves in the manner of an elastomer, so that in the case of a cable the sheathing is no longer able to fuse-on and, consequently, the electrical conductor(s) of the cable can be loaded to a greater extent.

Polyethylene can be crosslinked also by irradiation, for example with accelerated electrons. In so doing, it is possible to operate without a crosslinking agent. However, it is difficult uniformly to irradiate on all sides relatively thick, strand-form materials, such as relatively large cables. Particularly in the case of thicker strands, is is not readily possible to achieve satisfactory irradiation by simply turning the strand over (for example over a roller).

According to one aspect of the present invention, there is provided a method of guiding a strand-form material several times under a source of irradiation in order to achieve overlapping irradiation on all sides, comprising the steps of twisting the strand in one direction through approximately 45° before the first passage through the said irradiation, turning the material over after the first passage and passing the material under the source a second time, twisting the material through approximately 90° in the opposite direction to the said one direction either in the opposite direction to the said one direction either before or after turning the material over a second time, passing the material under the source a third time, turning the material over and passing it under the source a fourth time.

According to another aspect of the present invention, there is provided apparatus for carrying out the above method, including a strand twisting device which comprises discrete clamping jaws for gripping a strand and means for pivoting the jaws about the axis of a gripped strand.

Preferably, in the strand twisting device, said clamping jaws are pivotable with respect to each other between limits and are mounted on a support member of the device which extends approximately perpendicularly to the pivoting axis of said clamping jaws and is constrained to move along a twist guide of the device, the device including driving means for driving the support member.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made by way of example, to the accompanying drawings, in which:

Figure 1 shows apparatus in accordance with the invention for guiding a strand-form material under a source of irradiation;

Figure 2 shows a strand in cross-section with overlapping irradiation zones digrammatically indicated;

Figure 3 shows, in cross-section, a strand twisting device; and

Figure 4 shows one example of a drive arrangement for the device of Figure 3.

A source of radiation 1 in Figure 1 is disposed in a bunker 2 into which, through an

aperture 3, strand-form material 4 travels. The strand 4 travels over a guide roller 5 into a first strand twisting device 6 where it is twisted in one direction through approximately 45°, over a second guide roller 5 under and past irradiation source 1, and is thereupon turned through 180° by a deflecting roller 7. A further guide roller 5 carries the strand back to pass for a second time under the irradiation source 1. After the strand 4 has been irradiated on its second half-side, it travels over a deflecting roller 8 and a guide roller 5 into a second strand twisting device 9, where it is twisted through approximately 90° in the opposite direction relative to the twisting direction of the strand twisting device 6. Thereupon, the strand 4 travels through for a third time under the source of irradiation, whereby on this occasion a boundary zone of the preceding irradiation is irradiated in overlapping fashion. By twisting the strand 4 immediately prior to the third irradiation pass, *i.e.* subsequent to turning over the roller 8, the degree of twist can be especially accurately predetermined. After deflection due to a further deflecting roller (not shown) downstream of the deflecting roller 7, the strand then travels through for a fourth time under the source of irradiation and may then leave the bunker. For example, it could be deflected over a further deflecting roller (not shown) downstream of the deflecting roller 8 and, optionally, additionally cooled, and could then travel adjacent the source of irradiation over a guide roller 5 and leave the bunker through the outlet aperture 10.

In the cross-section shown in Figure 2 of an irradiated strand, the overlapping irradiation zones of the four passes of the strand 4 under the source 1 are designated 11, 12, 13 and 14.

Figure 3 shows one example of a strand twisting device for use in the apparatus of Figure 1. The device has tongs-shaped clamping jaws 16 and 17 which are relatively pivotable about a pivot 15 between limits defined by first, upper, opening rails 20 and 21 and second, lower, closure rails 22 and 23 against which rails lateral arms 18 and 19 of the jaws 16 and 17 can abut. By means of resilient members 24, the pressure applied to a strand 4 gripped between the clamping jaws 16 and 17 may be varied or adapt to non-uniformities in the strand. The opening rail and the closure rail may, on each side, also be comprised by the limbs of a generally U-section rail. The clamping jaws 16 and 17 are mounted on a support member 25 which extends substantially perpendicularly to the axis of the pivot 15 and is constrained to move along a twist guide 26. Rolling contact between the support member 25 and the twist guide 26 is afforded by rollers 27. The support member 25 engages, by means of an arm 28, an entrainment member 29 of a drive means which in this example, comprises a drive belt 30 arranged to move perpendicularly to the plane of the drawing. Further sets of clamping jaws on respective support members are arranged in spaced relationship perpendicular to the plane of the drawing. The support members may be spaced at intervals of, for example, approximately 20 cm. Due to the twist guide 26 extending in suitably sinuous configuration, the base point 31 of the support member 25 is deflected, in the direction of the arc of a circle 32 shown in dotted line, by pivoting about the axis of the gripped strand 4. Thereby, the strand 4 is twisted. The arm 28 engages progressively higher up the member 29 as the support member 25 is deflected to twist the strand 4.

Figure 4 shows one example of how, for a strand 4 travelling in the direction of an arrow 33, the rails 21, 23 and 26 and the belt 30 may be arranged. As the support member 25 is driven by the belt 30 alongside the strand 4, the closure rail 23 rises to press the respective clamping jaw 17 against the strand 4. The other jaw 16 is similarly pressed against the strand 4 to grip the strand. The rail 23 is twisted to follow the twist of the twist guide 26. For opening the clamping jaws, the opening rail 21 engages (at 34) the arm 19 of the clamping jaw 17 and then opens the jaw, so that the twisted strand 4 is released (the jaw 16 being similarly opened). Due to the twist of the twist guide 26, the arm 28 rises (Figure 3), and so the belt 30 is raised in the manner shown in the twisting zone, in order that the member 29 need not be excessively long.

It will be appreciated that, in use of the illustrated apparatus, the strand 4 is irradiated in overlapping fashion in all four sectors of its shell. Further, as the illustrated method is continuous, involving no intermediate steps of winding-up the strand 4, the twist variations in the strand are averaged out. Thus, it is possible to achieve substantially uniform irradiation on all sides of a strand-form material, without significant permanent change in the twist of the material. Particularly in this latter respect, the illustrated apparatus is improved over certain previously proposed arrangements known to us, in which an unacceptable permanent change in twist, after the irradiation process, may be obtained. In use of the twisting device of Figure 3, the twisting obtained thereby may be uniform and more readily predetermined than certain previously proposed arrangements known to us.

WHAT WE CLAIM IS:

1. A method of guiding a strand-form material several times under a source of irradiation in order to achieve overlapping

irradiation on all sides, comprising the steps of twisting the strand in one direction through approximately 45° before the first passage through the said irradiation, turning the material over after the first passage and passing the material under the source a second time, twisting the material through approximately 90° in the opposite direction to the said one direction either before or after turning the material over a second time, passing the material under the source a third time, turning the material over and passing it under the source a fourth time.

2. Apparatus for carrying out a method according to claim 1 including a strand twisting device which comprises discrete clamping jaws for gripping a strand and means for pivoting the jaws about the axis of a gripped strand.

3. Apparatus according to claim 2, wherein said clamping jaws are pivotable with respect to each other between limits and are mounted on a support member of the device which extends approximately perpendicularly to the pivoting axis of said clamping jaws and is constrained to move along a twist guide of the device, the device including drive means for driving the support member.

4. Apparatus according to claim 3, wherein the clamping jaws are tongs-shaped, each jaw having a lateral arm which is moveable between limits defined by first and second rails of the device.

5. Apparatus according to claim 4, wherein the first and second rails are cooperable with the jaws to open and close the jaws.

6. Apparatus according to any one of claims 3 to 5, wherein the drive means is arranged to drive the support member by means of an arm extending from the support member.

7. Apparatus according to any one of claims 3 to 6, wherein a plurality of sets of jaws on respective support members are arranged to be driven by the drive means.

8. Apparatus for guiding a strand-form material under a source of irradiation, the apparatus being substantially as hereinbefore described with reference to Figure 1 of the accompanying drawings.

9. Apparatus for guiding a strand-form material under a source of irradiation, the apparatus being substantially as hereinbefore described with reference to Figures 1, 3 and 4 of the accompanying drawings.

10. A method of guiding a strand-form material under a source of irradiation, the method being substantially as hereinbefore described with reference to the accompanying drawings.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

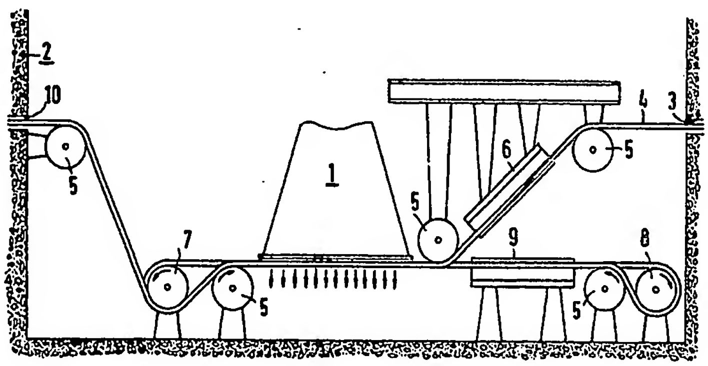

Fig.1

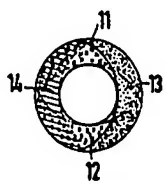

Fig.2

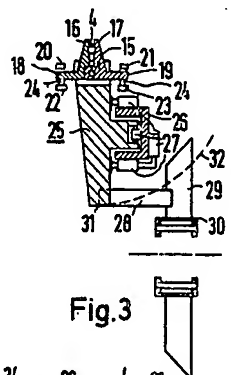

Fig.3

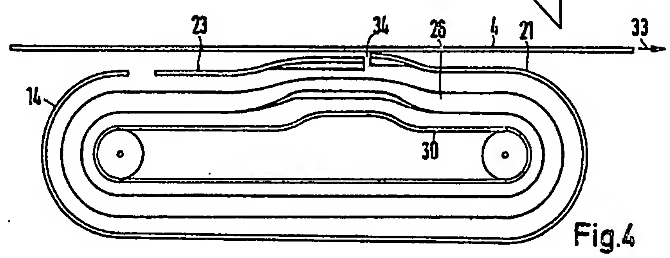

Fig.4